

PATENT  
Atty Docket KLAC0016

#11  
4.29.03  
Crown

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Group Art Unit: 2877

DIETER MUELLER ET AL.

Examiner: Hwa S. Lee

Title: REDUCED COHERENCE  
SYMMETRIC GRAZING INCIDENCE  
DIFFERENTIAL INTERFEROMETER

Serial No.: 09/543,604

Filed: April 7, 2000

RECEIVED  
APR 25 2003  
TECHNOLOGY CENTER 2800

DECLARATION UNDER 35 C.F.R. 1.131

Hon. Commissioner of Patents and Trademarks  
Washington, D.C. 20231

Sir:

We, Dieter Mueller, Daniel Ivanov Kavaldjiev, and Rainer Schierle, do hereby declare as follows:

1. We are coinventors of currently pending claims 1-23 of the above-identified patent application.
2. Prior to June 3, 1999, we conceived of the idea of a Reduced Coherence Symmetric Grazing Incidence Differential Interferometer as described and claimed in our application. Conception and all acts described herein occurred in WTO countries.
3. Rainer Schierle prepared drawings and entered passages in his notebook of certain aspects of the invention reflected in the aforementioned currently pending claims. A copy of relevant portions of the notebook prepared by Mr. Schierle ("the Notebook") is attached hereto as Exhibit A.

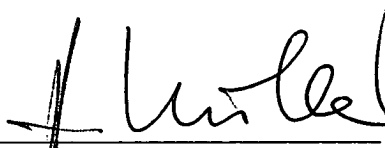
4. Specifically, the Notebook shows the "double mirror" concept conceived by us and the dual sided inspection of a specimen, such as a semiconductor wafer. At the top of the first page, each side of the two sided specimen is parallel to a reflecting surface, such as a mirror, and illumination is directed toward the specimen and both reflective surfaces.
5. Further evidence of conception prior to June 3, 1999 is illustrated in Exhibit B, a report prepared by inventor Rainer Schierle showing simulated results for particular arrangements of a specimen inspection system. In particular, the letters "DM" indicate a "double mirror" design such as that illustrated in the Notebook. The documents presented in Exhibit B were prepared by Rainer Schierle prior to June 3, 1999.
6. Subsequent to conception but prior to June 3, 1999, we began exploring various designs intended to produce improved scanning of semiconductor wafers. We explored different inspection designs, including performing an analysis of at least two designs. We eventually concluded that a reduced coherence design could offer benefits not found in certain non-reduced coherence designs. With the assistance of certain persons employed by KLA-Tencor Corporation, we began analyzing, working on, and constructing a prototype of the reduced coherence design.
7. We and others employed by KLA-Tencor Corporation began working on and constructing a device including the reduced coherence design prior to June 3, 1999. We procured various pieces prior to June 3, 1999 for use in the low coherence prototype.
8. We worked together in building the design, including placing a semiconductor wafer in a measurement cell along with two mounted mirrors similar to the design presented in the top portion of FIG. 1B of U.S. Patent Application Serial No. 09/543,604 and taking measurements of the wafer using the reduced coherence prototype. On information and belief, completion of construction of the reduced coherence prototype and measurement of a two sided semiconductor wafer using the reduced coherence prototype occurred either shortly before or shortly after June 3, 1999.
9. Attached hereto as Exhibit C is an email from Daniel Kavaldjiev to Dieter Mueller and Rainer Schierle dated July 30, 1999. The email includes two scans

of actual semiconductor wafers, one employing a diffuser and the other with the diffuser off. Both of these scans were produced using the reduced coherence prototype.

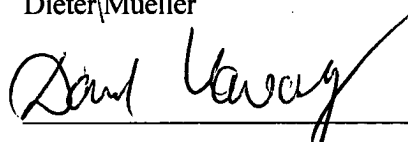
10. Based on the email of Exhibit C, we reduced the reduced coherence invention to practice before July 30, 1999. Our efforts from the period prior to June 3, 1999 to actual reduction to practice included procuring parts for the reduced coherence prototype, setting up the reduced coherence prototype including placing mirrors in the measurement cell, setting other components in the measurement cell including the gratings, and testing the design.

The undersigned, being hereby warned that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of any application or patent issuing therefrom, declares that the facts set forth in this declaration are true, and that all statements made of his own knowledge are true and all statements made on information and belief are believed to be true.

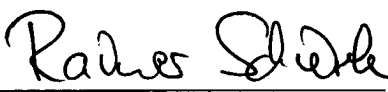
Dated: April 17, 2003

  
Dieter Mueller

Dated: April 17, 2003

  
Daniel Ivanov Kavaldjiev

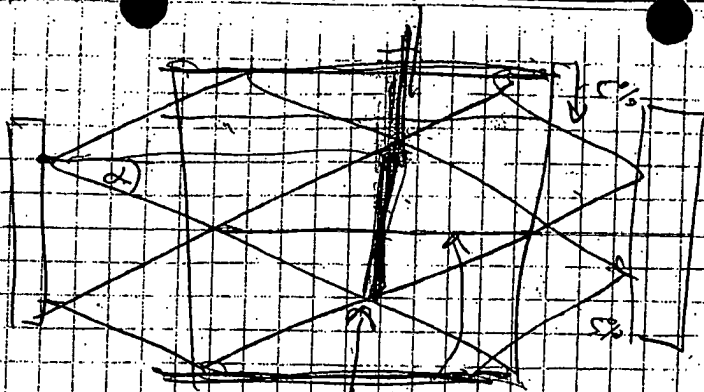
Dated: April 17<sup>th</sup>, 2003

  
Rainer Schierle



# **EXHIBIT A**



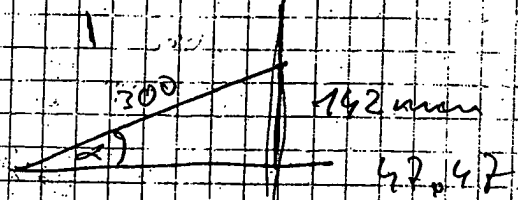


550 mm

860 mm

263

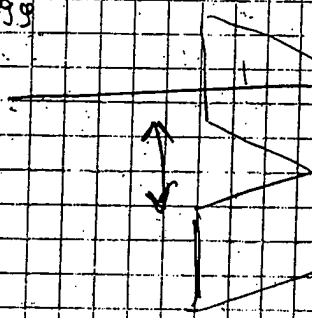
299



300

142 mm

42.42



24 +

0.440

24

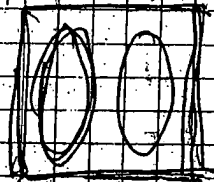
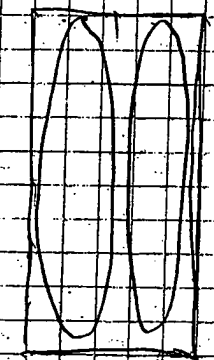
0.440

48

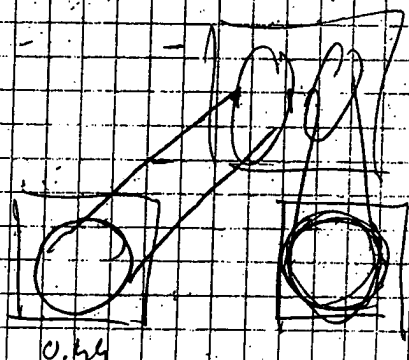
48

144

Harmonization

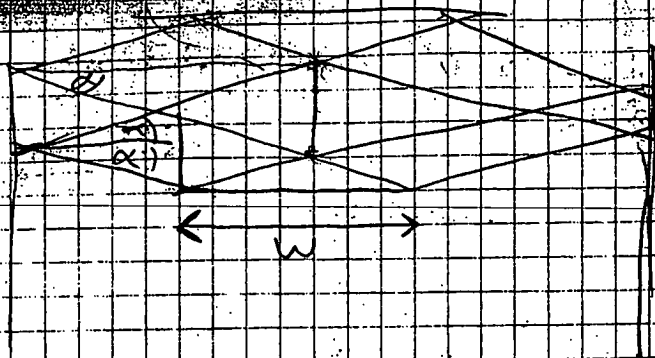


0.44



0.44





$$\alpha = 9.105^\circ \quad 300 \text{ mm}$$

Bildbreite: 48.08 mm

Luftpalt = 2 mm je Seite

52 mm  $\Rightarrow$  Mindestlänge von Mille =  $52 / \tan \alpha = 324.46 \text{ mm}$

$$\frac{52}{x} = \tan \alpha \quad x = \frac{52}{\tan \alpha}$$

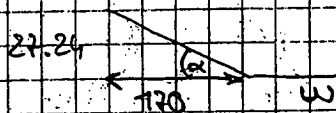
• Gitterabstand = 320 mm

$$\Rightarrow (51.28 - 48) / 2 = 1.6 \text{ mm Gitterbreite}$$

• Folter 1 & 2:

$$\text{Mindestbreite} = 27.24 \times 2 + 1808 \times 2 = 150.64$$

bei 0. Ordnung



Mindestbreite bei 3. Ordnung = 167.8

Gitterbreite = 165 mm

$$\text{Pixel size} = 2048 \times \frac{165.08}{165} = 596.77$$

$$\text{Pixel size} = 0.5027 \text{ mm}$$

$$\text{Pixel size} = 0.18 \text{ mm}$$

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# **EXHIBIT B**

### Summary of Design Criteria for LS3 Topo

| Camera               | Z points | Y points | Frames per se  | Resolution [bit] | Laser Wave Length           | [µm]                     |
|----------------------|----------|----------|----------------|------------------|-----------------------------|--------------------------|
|                      | 1024     | 1024     | 2.1            | 8                |                             | 0.633                    |
| <b>Scan Matrix</b>   |          |          |                |                  |                             |                          |
|                      |          | Camera 1 | Camera 2       | Camera 3         | Order of Diffraction(Angle) |                          |
| Y Images             | 1        | 1        | 1              | 0                | 1                           | 0.160263554              |
| Z Images             | 1        | 1        | 1              | 0                | 2                           | 0.333625236              |
|                      |          |          |                |                  | 3                           | 0.539345391              |
| <b>Systems</b>       |          |          |                |                  |                             |                          |
| Geometry             | Topo     |          |                | General          |                             |                          |
|                      | Design   |          |                | G1 - G2          |                             |                          |
| 300                  | 200 RD   | 550      | 140            | 138              | 302                         | 7.81                     |
| 300                  | 200 DM   | 640      | 140            | 138              | 302                         | 7.81                     |
| 300                  | 300 RD   | 800      | 182            | 178              | 302                         | 7.81                     |
| 300                  | 300 DM   | 800      | 182            | 178              | 302                         | 7.81                     |
| 200                  | 200 RD   | 550      | 140            | 124              | 202                         | 7.81                     |
| 200                  | 200 DM   | 550      | 140            | 124              | 202                         | 7.81                     |
| <b>Geometry Mode</b> |          |          |                |                  |                             |                          |
|                      |          |          | Grating Size Y | Grating Use Y    | Width of Image              | Width Grating Z Res [nm] |
|                      |          |          |                |                  |                             | Pixel Y [µm]             |
|                      |          |          |                |                  |                             | 0.420                    |
|                      |          |          |                |                  |                             | 0.420                    |
|                      |          |          |                |                  |                             | 0.542                    |
|                      |          |          |                |                  |                             | 0.542                    |
|                      |          |          |                |                  |                             | 0.378                    |
|                      |          |          |                |                  |                             | 0.378                    |



Nanopro

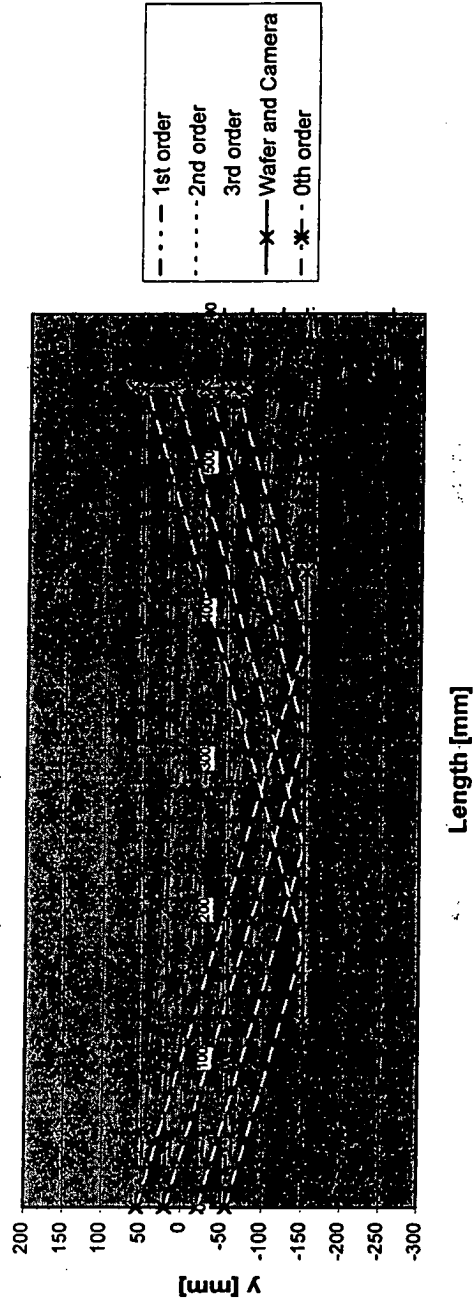
Summary of LS3 Topo Design

| Topo Mode    |           |               |                 |          |              |              |           |               |
|--------------|-----------|---------------|-----------------|----------|--------------|--------------|-----------|---------------|
| Pixel Z [um] | Acq. Time | Analysis Time | Width of ImageZ | Res [nm] | Pixel Y [um] | Pixel Z [um] | Acq. Time | Analysis Time |
| 0.147        |           | 107.87        |                 | 2.60     | 0.125        | 0.147        |           |               |
| 0.147        |           | 107.87        |                 | 2.60     | 0.125        | 0.147        |           |               |
| 0.147        |           | 161.80        |                 | 2.60     | 0.161        | 0.147        |           |               |
| 0.147        |           | 161.80        |                 | 2.60     | 0.161        | 0.147        |           |               |
| 0.099        |           | 107.87        |                 | 2.60     | 0.112        | 0.099        |           |               |
| 0.099        |           | 107.87        |                 | 2.60     | 0.112        | 0.099        |           |               |

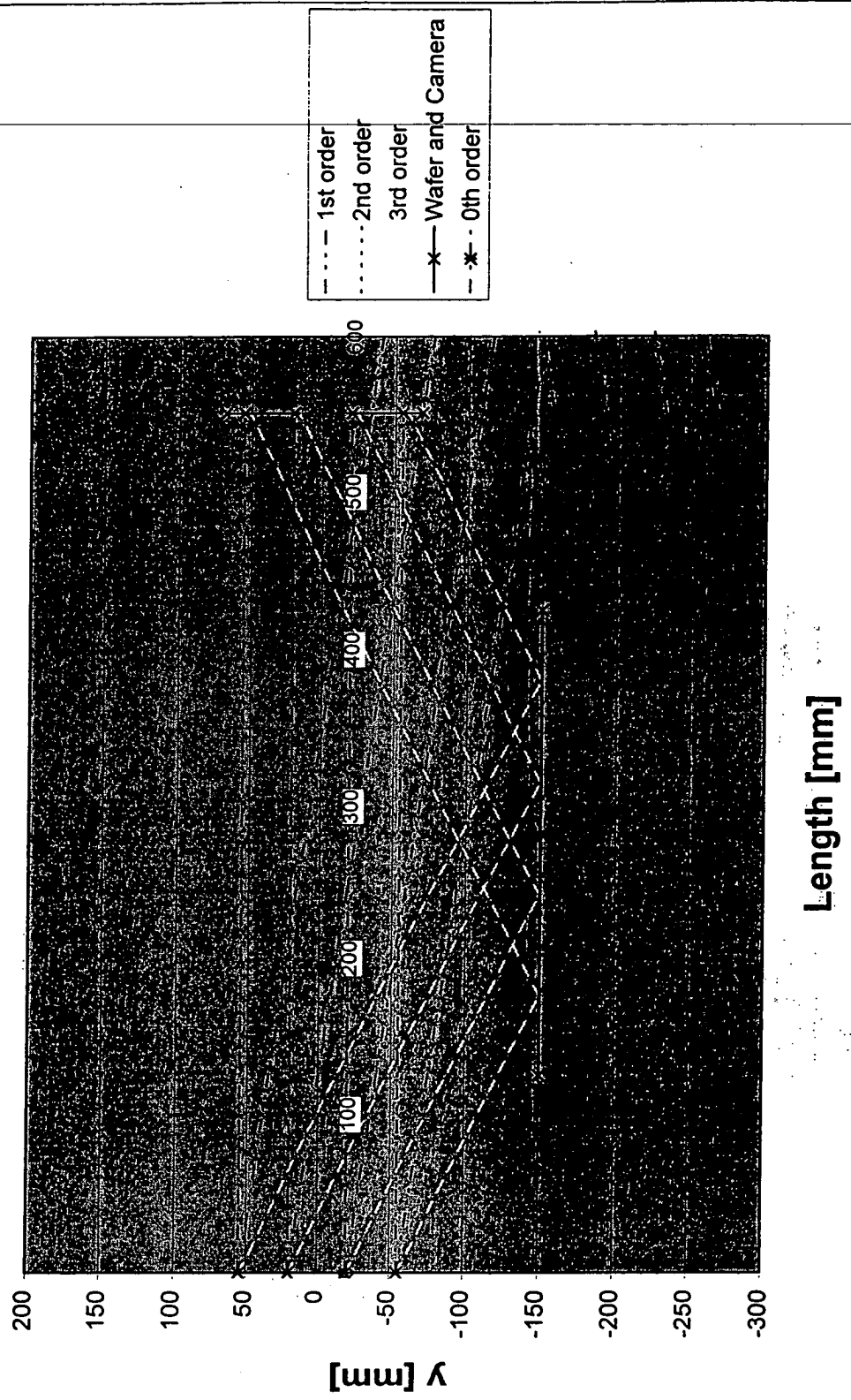
Tab1

| Reflection on Wafer |                | Model        | 550DMT      |             |             |            |         |                |  |
|---------------------|----------------|--------------|-------------|-------------|-------------|------------|---------|----------------|--|
| Length              | Wafer Position | Wafer Length | tan alpha   | tan beta    | tan gamma   | WaferInUse | G2InUse | TopMirrorInUse |  |
| 550                 | -150           | 300          | 0.160263554 | 0.333625236 | 0.539345391 | 1          | 1       | 1              |  |
|                     |                |              |             |             |             |            |         | Position       |  |
|                     |                |              |             |             |             |            |         |                |  |
| Points              | X Min          | X Max        | P1 X        | G2 Y1       | P2 X        | G2 Y2      | P3 X    | G2 Y3          |  |
| 20.03               | 125            | 425          | 1060.94     | -231.89     | 509.64      | -136.54    | 315.25  | -23.39         |  |
| 55                  | 125            | 425          | 1279.14     | -266.86     | 614.46      | -171.51    | 380.09  | -58.36         |  |
| 20.03               | 125            | 425          | 1060.94     | -231.89     | 509.64      | -136.54    | 315.25  | -23.39         |  |
| 20.03               | 125            | 425          | 1060.94     | -231.89     | 509.64      | -136.54    | 315.25  | -23.39         |  |
| 20.03               | 125            | 425          | 1060.94     | -231.89     | 509.64      | -136.54    | 315.25  | -23.39         |  |
| -20.03              | 125            | 425          | 810.98      | -191.83     | 389.57      | -96.48     | 240.98  | 16.67          |  |
| -55                 | 125            | 425          | 592.77      | -156.86     | 284.75      | -61.51     | 176.14  | 51.64          |  |

Reflection on Wafer, L=550mm, Double Mirror Topography, 3 Scan Positions in X for 300mm



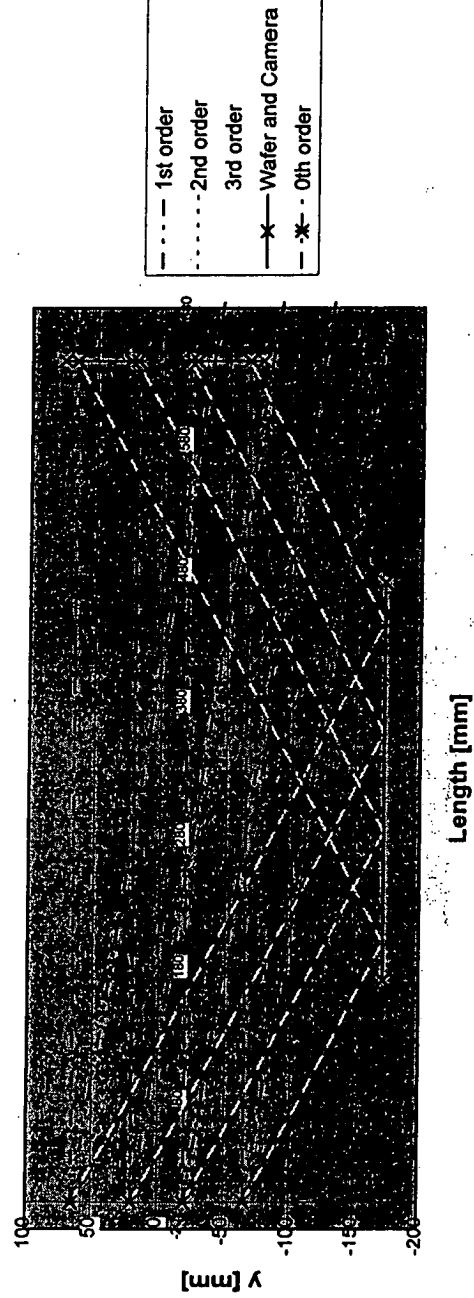
Reflection on Wafer, L=550mm, Double Mirror Topography, 3 Scan Positions in X for 300mm



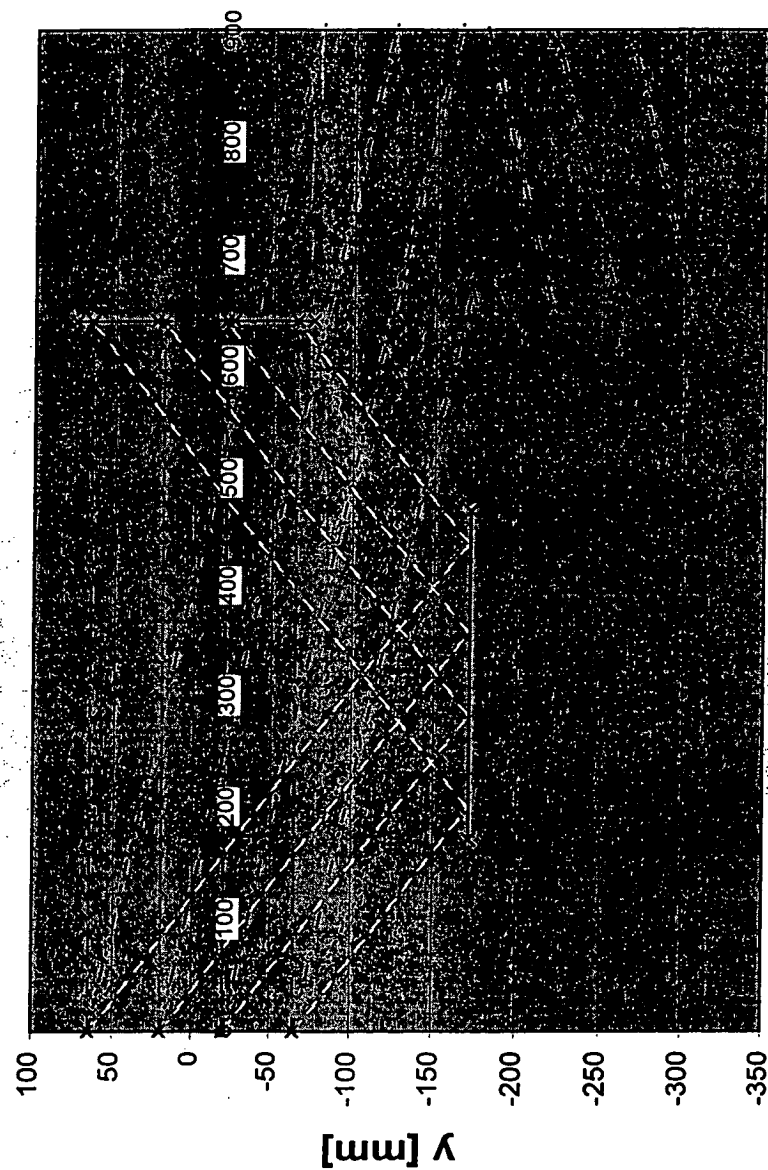
Tab1

| Reflexion on Wafer |       | Model          | 640DMT2CXS   |             |             |             |            |         |                |  |
|--------------------|-------|----------------|--------------|-------------|-------------|-------------|------------|---------|----------------|--|
| Länge              | 640   | Wafer Position | Wafer Length | tan alpha   | tan beta    | tan gamma   | WaferInUse | G2InUse | TopMirrorInUse |  |
|                    |       | -172           | 300          | 0.160263554 | 0.333625236 | 0.539345391 | 1          | 1       | Position       |  |
| Punkte             | X Min | X Max          | P1 X         | G2 Y1       | P2 X        | G2 Y2       | P3 X       | G2 Y3   |                |  |
| 65                 | 170   | 470            | 1478.81      | -306.43     | 710.38      | -195.48     | 439.42     | -63.82  |                |  |
| -65                | 170   | 470            | 667.65       | -176.43     | 320.72      | -65.48      | 198.39     | 66.18   |                |  |
| 65                 | 170   | 470            | 1478.81      | -306.43     | 710.38      | -195.48     | 439.42     | -63.82  |                |  |
| 65                 | 170   | 470            | 1478.81      | -306.43     | 710.38      | -195.48     | 439.42     | -63.82  |                |  |
| 65                 | 170   | 470            | 1478.81      | -306.43     | 710.38      | -195.48     | 439.42     | -63.82  |                |  |
| -20                | 170   | 470            | 948.44       | -221.43     | 455.60      | -110.48     | 281.82     | 21.18   |                |  |
| 20                 | 170   | 470            | 1198.03      | -261.43     | 575.50      | -150.48     | 355.99     | -18.82  |                |  |

Reflection on Wafer, L=640mm, Double Mirror, 200 direct, 300 with 1 Scan In X, 2 Cameras



# Reflection on Wafer, L=640mm, Double Mirror, 200 direct, 300 with 1 Scan in X, 2 Cameras



Length [mm]

From: Kavaldjiev, Daniel [Daniel.Kavaldjiev@kla-tencor.com]  
Sent: Friday, July 30, 1999 5:41 PM  
To: Mueller, Dieter; Schierle, Rainer  
Subject: diffuser effect

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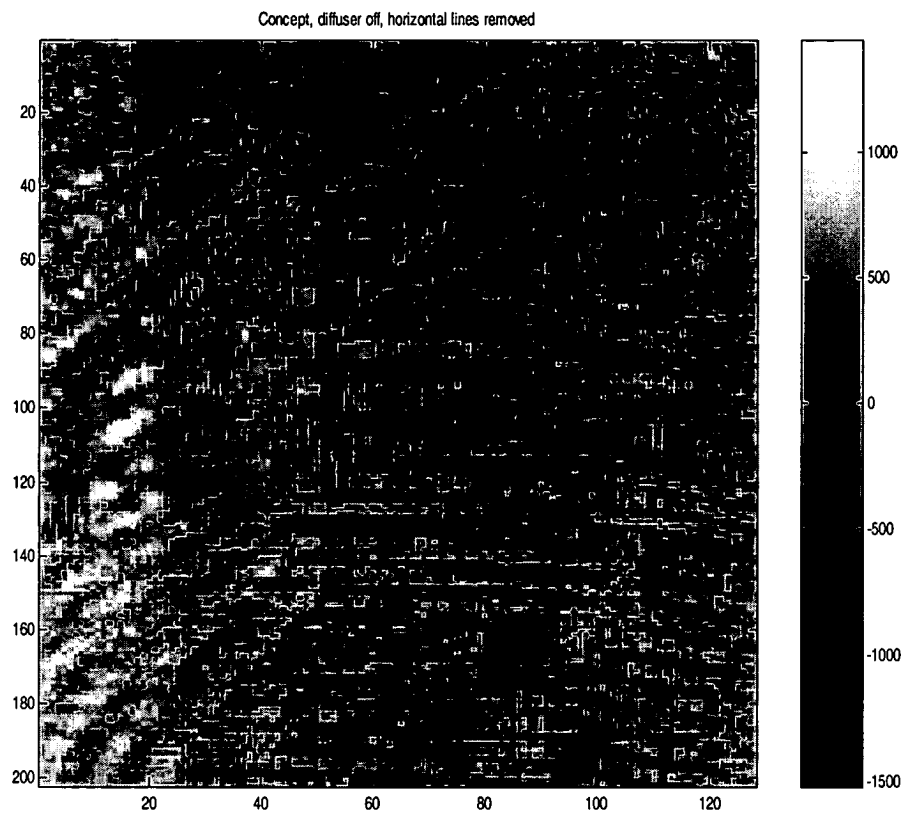
Dieter, Reiner,

Included is a word file with two pictures of 30 nm pattern wafer measured with and without the diffuser. Both images are filtered for the horizontal lines from the camera.

Regards,  
Dan

# Concept, 30 nm pattern wafer measurement

Diffuser off, horizontal lines removed



# Diffuser on, horizontal lines removed

Concept, Diffuser on, horiz lines removed [Angstroms] (cp30-1.mat)

